



# The Lake Tahoe Atmospheric Deposition Study (LTADS)

Joint ARB & SWRCB Workshop on  
Atmospheric Deposition and Water Quality  
February 9, 2006

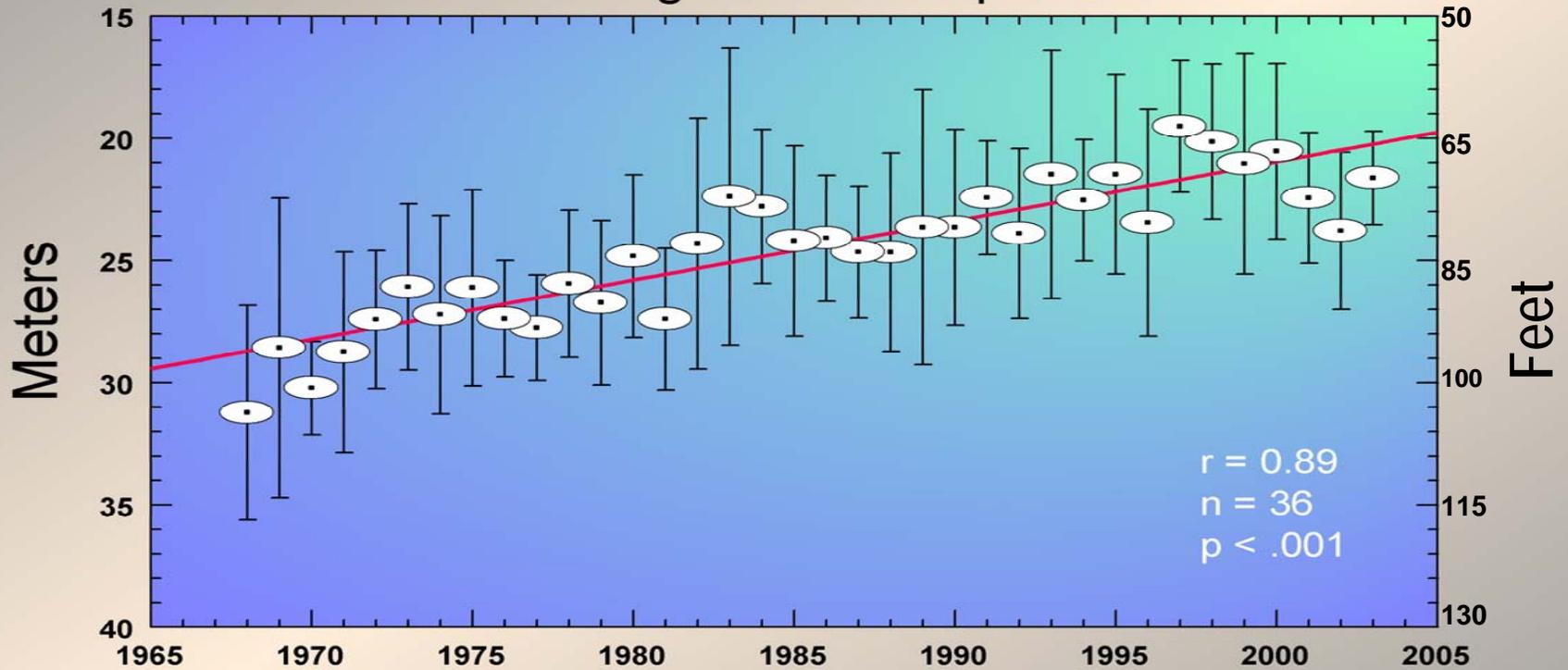
# Presentation Outline

- Background
- Objectives & Study Design
- Results

# The Problem: Declining Lake Clarity

## LAKE TAHOE

Annual Average Secchi Depth  $\pm$  1 s.d.



TAHOE RESEARCH GROUP  
UC DAVIS

# Stakeholders & Study Participants

- Air Resources Board
- Tahoe Regional Planning Agency (TRPA)
- Lahontan Regional Water Quality Control Board
- Nevada Division of Environmental Protection
- U.S. EPA
- U.S.D.A. Forest Service
- DRI, TRG, UC Davis, UC Berkeley, UC Riverside

Cost = ~ \$2.3 million

# LTADS Objectives & Study Design



# LTADS Objectives

- Dry deposition of nitrogen, phosphorus and particles
- Source attribution and source categories
- Investigate transport of air pollutants to the basin
- Ozone levels and effect on forest health

# LTADS Study Design

## Deposition Rate = Concentration x $V_d$

- Field Study Measurements (Nov 2002 - Dec 2003)
  - Air Quality → Concentrations
  - Meteorology → Site specific, seasonal, hourly  $V_d$
- Inferential Source Information
- Improve the Emissions Inventory
- Peer Review

# Peer Reviewers

- Professor Thomas Cahill, UC Davis
- Professor Keith Stolzenbach, UC Los Angeles
- Professor Gail Tonnesen, UC Riverside
- Professor Akula Venkatram, UC Riverside
- Professor Anthony Wexler, UC Davis

# Primary Instruments

**winds aloft**

RWP/RASS also provides  
temperature aloft

**Mini-Sodar**



**TSP**

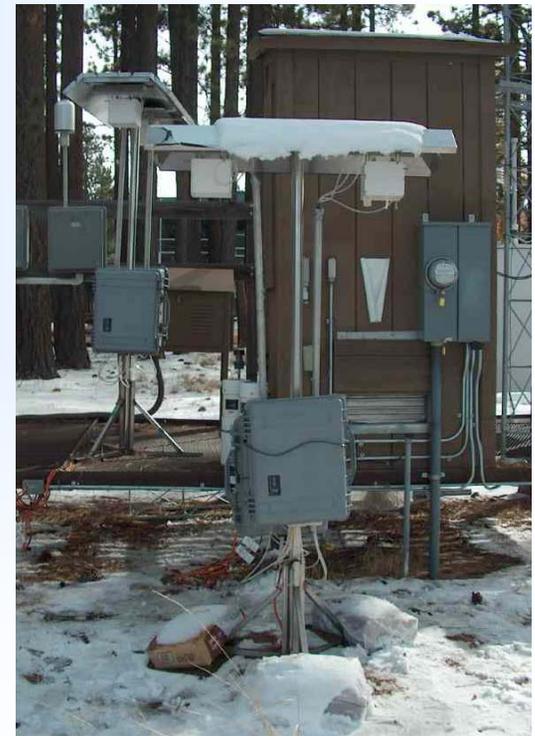
**and PM species**  
on buoys & piers

**Mini-Volume Sampler**



**TSP, PM10, & PM2.5,**  
**& PM species, and**  
**NH<sub>3</sub> & HNO<sub>3</sub>**  
at land sites

**Two-Week Sampler**

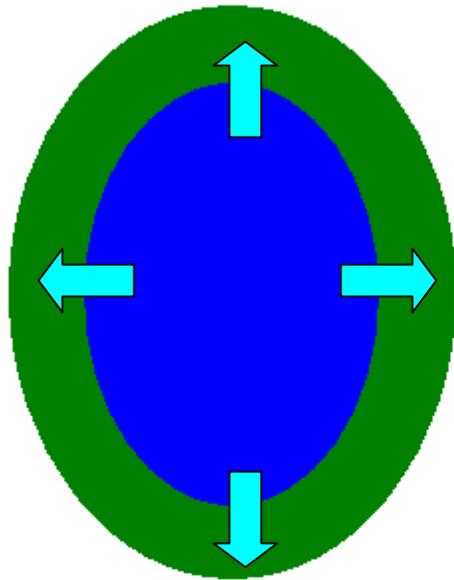


# Typical Air Flow Patterns

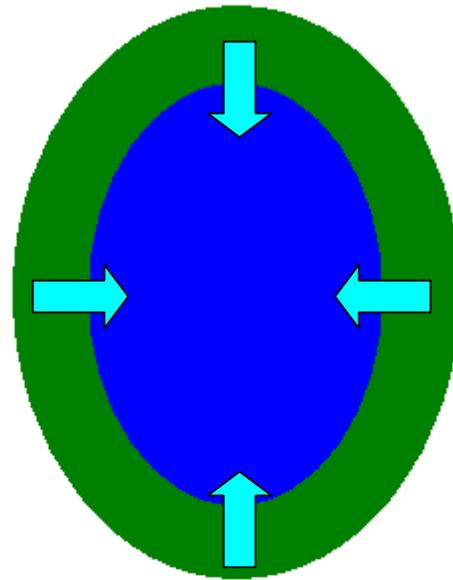
synoptic

meso-scale

Day



Night



W vertical cross section E

W vertical cross section E

# LTADS Diurnal Air Flow, Winter 2003

SLT – Sandy Way

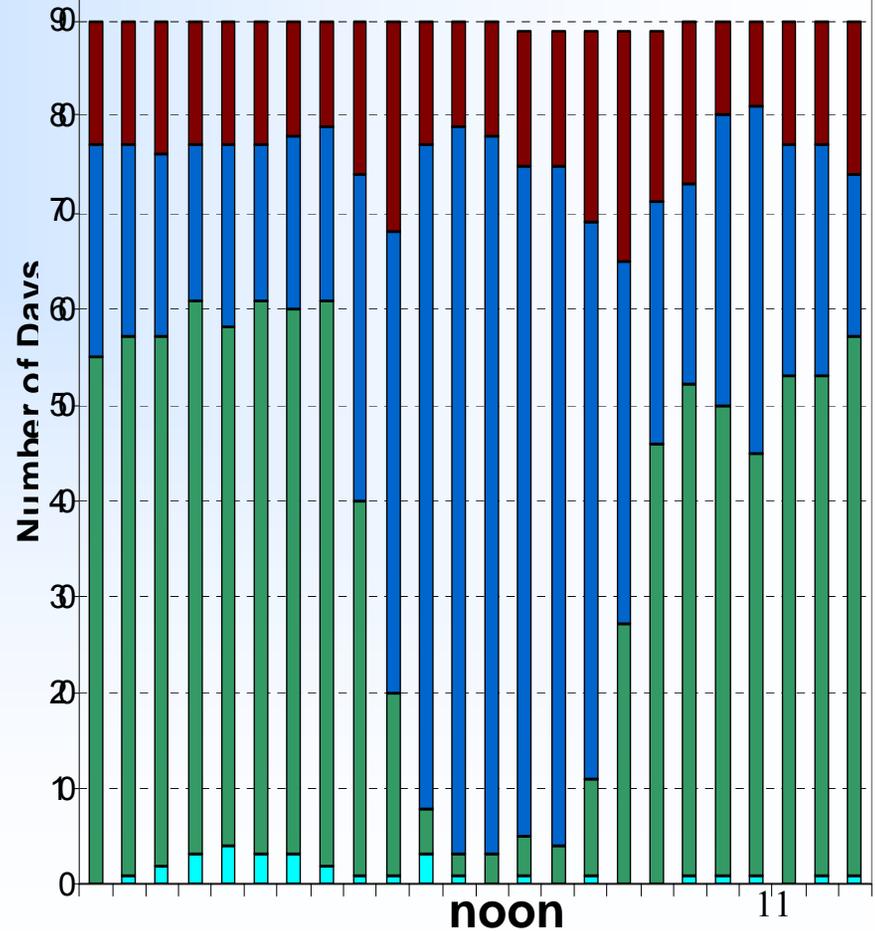
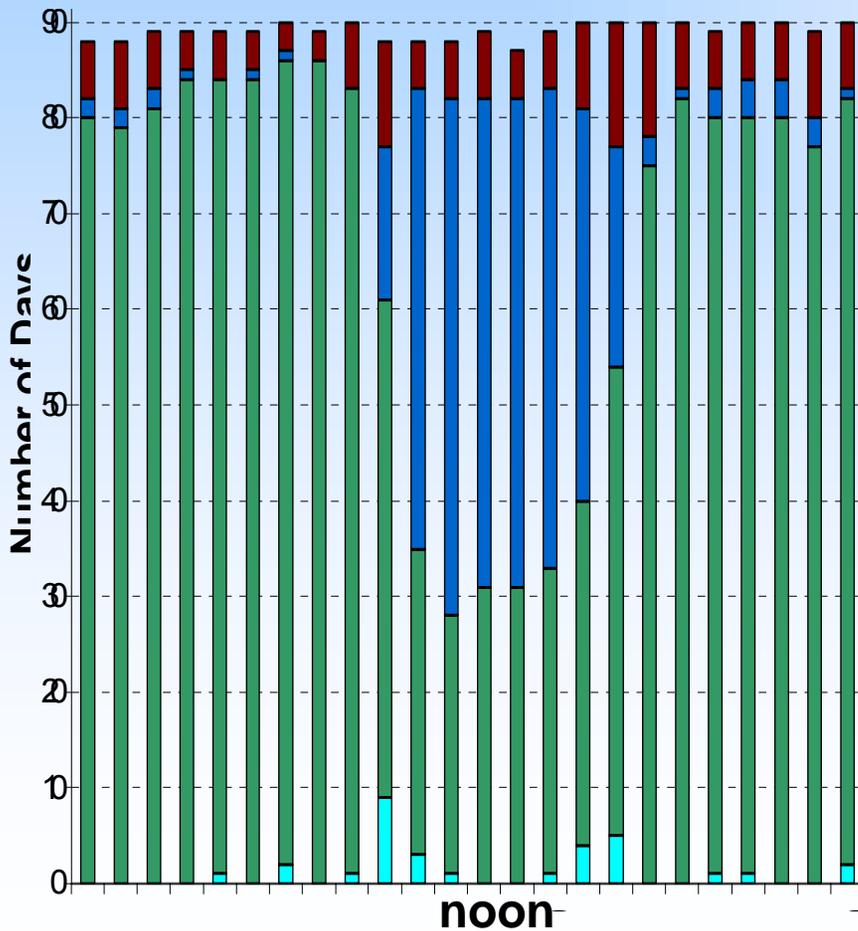
LF – Coast Guard

CALM

OFFSHORE

ONSHORE

SIDESHORE



# LTADS Monitoring Network

- ▲ Meteorology aloft
- ★ AQ – gas & PM
- ◆ AQ - PM
- ✦ AQ – single gas
- ▼ Deposition
- On-Lake
- ▲ Meteorology aloft

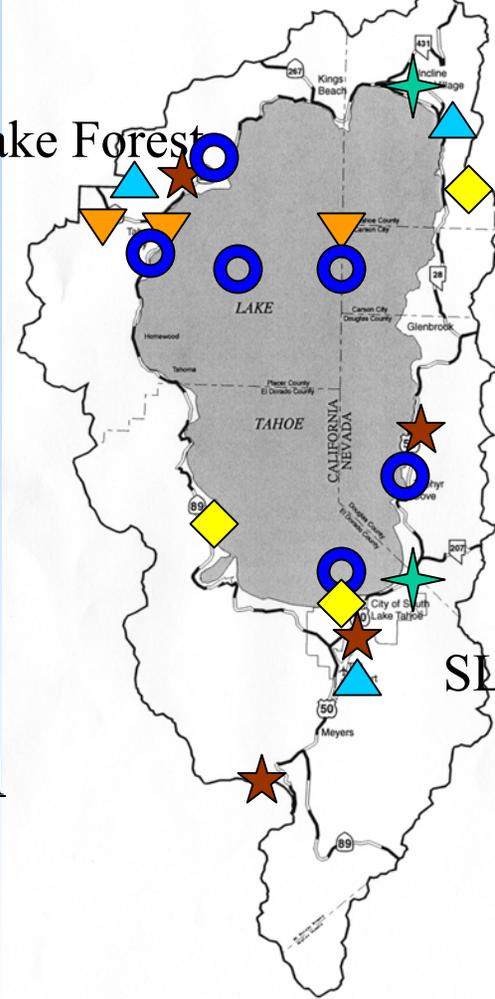


Big Hill

Lake Forest

Thunderbird Lodge

SLT-Sandy Way



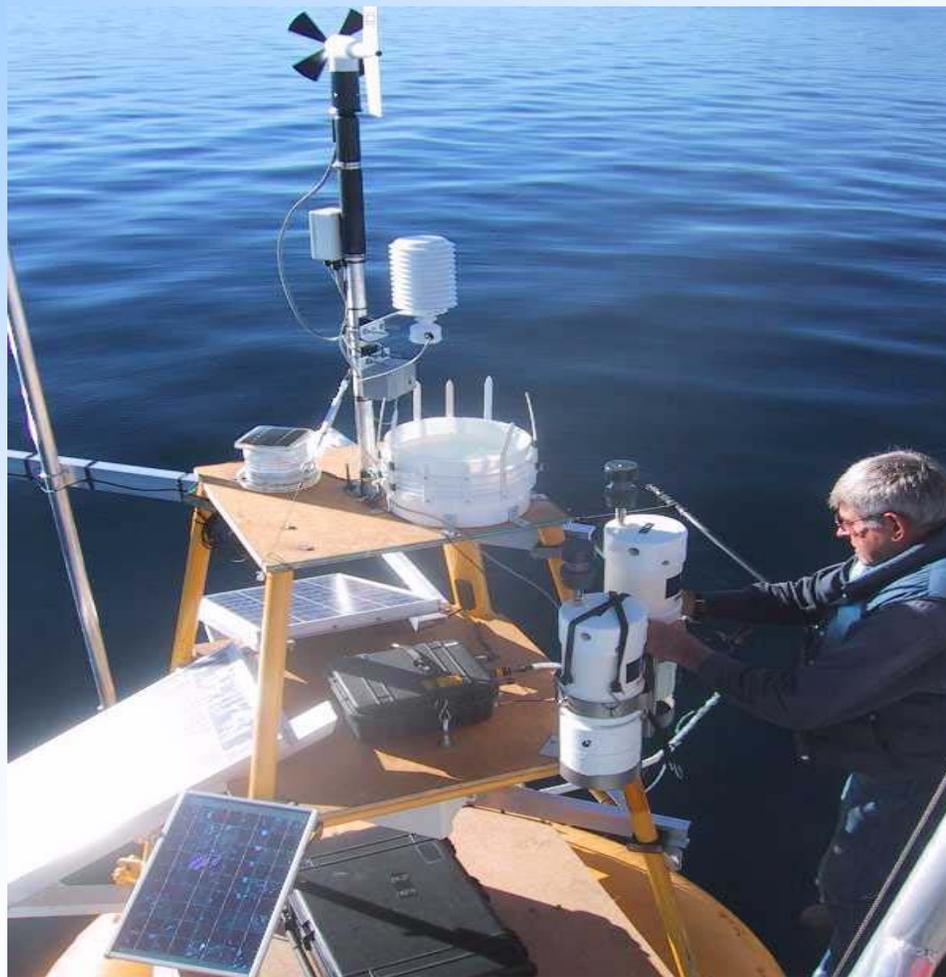
# Sites in South Lake Tahoe



# Special Challenges



# Results

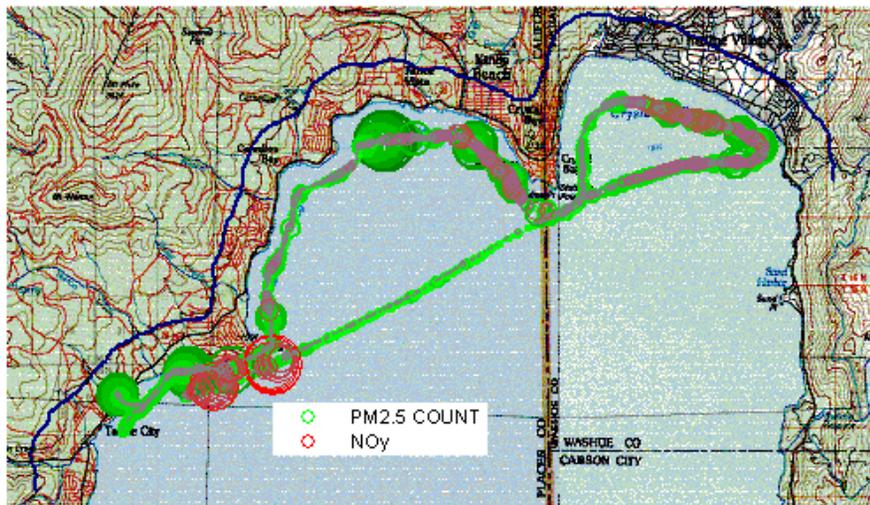


# LTADS Deposition Estimates

metric tons to the Lake's surface/year

	LTADS Dry	LTADS Dry + Wet	Jassby (1994)
Nitrogen	110 (68 – 150)	180 (94 – 300)	234
Phosphorus	2.2 (0.6 – 3.6)	6.4 (1.8 – 15)	12
PM	590 (270 – 1100)	1500 (650 – 3100)	na

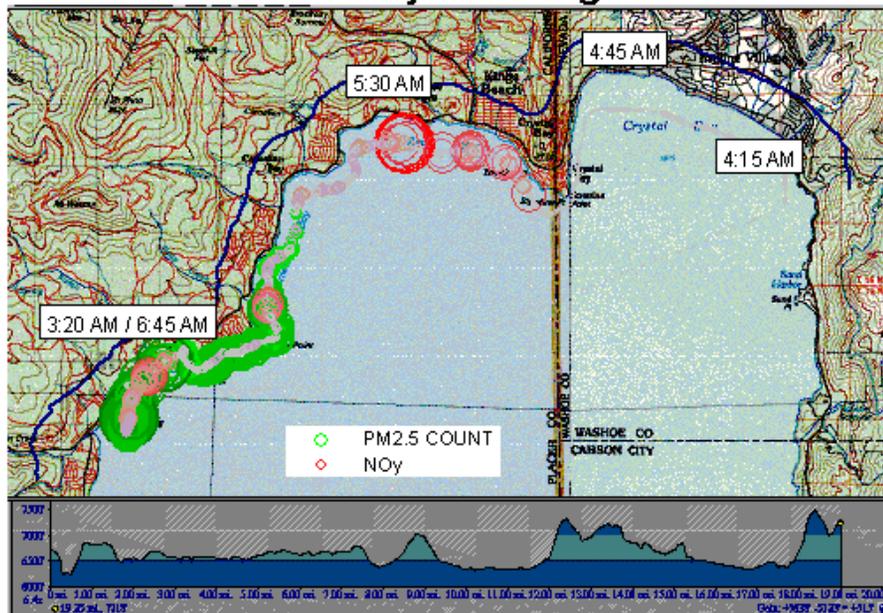
## Particle Counts and NO<sub>y</sub> - Evening Cruise 07-09-2003



# On-Lake Experiment July 9 -10, 2003

- Vehicle exhaust and wood smoke near population centers in evening
- Drainage flushes shore zone overnight
- Vehicle exhaust precedes smoke in morning
- Effect confined to near-shore

## Particle Counts and NO<sub>y</sub> - Morning Cruise 07-10-2003



# Transport Estimate

- $\text{NO}_x$  - transport is unlikely
- Coarse PM - largely local sources
- Fine PM - local sources and possibly a regional background including transport of phosphorus from Asian soil

# Emission Inventory Improvement

- Source Sampling
  - Prescribed Fires
  - Neighborhood Wood Smoke
  - Paved/Unpaved Road Dust
  - Sanding/de-icing
  - Motor Vehicles
- Activity Characterization
  - Prescribed & Wild Fires
  - Wood Burning
  - Sanding/de-icing
  - Motor Vehicles



# Summary

- LTADS is the most comprehensive study of atmospheric deposition on Lake Tahoe to date
- Atmospheric deposition appears to be a significant source of nitrogen to the Lake
- Local sources of nitrogen & coarse PM are important

# Acknowledgements

- ARB's Monitoring & Laboratory Division
- ARB's Planning & Technical Support Division
- Tahoe Regional Planning Agency
- Lahontan Regional Water Quality Control Board
- Tahoe Research Group
- U.S. EPA
- U.S.D.A. Forest Service
- Nevada Division of Environmental Protection
- UC Berkeley, UC Davis, UC Riverside, DRI, NOAA
- Peer Reviewers

# Thank you

